

Emergence behaviour in *Petalura gigantea* (Odonata: Petaluridae): confirmation of upright emergence

Ian R. C. Baird*

College of Health and Science, University of Western Sydney, Locked Bag 1797, Penrith South NSW 1797, Australia

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Two distinct emergence styles have been reported in odonates, with both the upright and hanging back emergence reported in the Petaluridae, between and within individual species, including *Petalura gigantea*. This paper reports three additional observations of upright emergence in *P. gigantea*, providing further evidence that this emergence style is the norm for the species.

Keywords: *Petalura gigantea*; Odonata: Petaluridae; emergence behaviour; upright emergence

Introduction

Eda (1959) identified two distinct emergence types in Odonata, the “upright” and “hanging back” postures. Corbet (1962) later noted that “within a single species there can be much individual variation, though seldom beyond the limits for the type defined by Eda”. The first account of emergence behaviour in the Petaluridae (Odonata: Anisoptera) was by Tillyard (1917) who provided illustrations and a description of hanging back emergence for *Petalura gigantea* Leach. This emergence style is typical of all other anisopteran families except the Gomphidae (Corbet, 1999). Although Tillyard (1909) had previously reported having observed many individuals in the process of emergence, no specific emergence behaviour was reported, and the later illustration and description of a hanging back emergence style in *P. gigantea* (Tillyard, 1917) did not include any details of location or date of observation. There is thus some ambiguity as to whether his illustrations and description actually represented observations of *P. gigantea*, or whether it was simply used as an example to illustrate emergence behaviour but focused on the hanging back style. Tillyard made no mention of the upright emergence posture used by gomphids and zygopterans. Wolfe (1953) subsequently reported that emergence in *Uropetala* Selys was similar to that of *P. gigantea* (as reported by Tillyard, 1917), although specific details were not provided. Svihla (1960) also reported a hanging back emergence style in *Tanypteryx hageni* (Selys). Upright emergence was, however, subsequently documented elsewhere in the Petaluridae, in *T. pryori* (Selys) (Eda, 1959), *Uropetala carovei* (White) (Winstanley, Winstanley, & Gordine, 1981) and *Tachopteryx thoreyi* (Hagen) (Dunkle, 1981). These reports led a number of researchers (Corbet, 1999; Eda, 1963, 1964; Winstanley, 1981; Winstanley et al., 1981) to suggest that the previous reports of hanging

*Address for correspondence: 3 Waimea St, Katoomba NSW 2780, Australia. Email: petalurids@gmail.com

back emergence (Svihla, 1960; Tillyard, 1917) required confirmation. Baird and Ireland (2006) subsequently documented an observation of upright emergence in *P. gigantea* and suggested that either upright emergence was the norm for Petaluridae, or there might be a high level of inter- or intra-specific variability in emergence style. No observations of emergence behaviour have been reported for the remaining petalurids: *Petalura hesperia* Watson, *P. litorea* Theischinger, *P. ingentissima* Tillyard, *P. pulcherrima* Tillyard (Australia) and *Phenes raptor* Rambur (Chile and Patagonian Argentina). This paper reports on a study to document additional observations of emergence behaviour in *P. gigantea* and provide further evidence that an upright emergence style is the norm for the species.

Methods

Study location

This project was undertaken in the Blue Mountains, New South Wales, Australia (150°20'E, 33°40'S; Figure 1) during November 2007 and 2008, in conjunction with a larger landscape-scale study of *P. gigantea*. In an attempt to document additional observations of upright emergence in *P. gigantea*, following the observations of Baird and Ireland (2006), two swamp sites (PMH01, PBB01; for location details see Baird, 2012, Appendix 1) with large emergence events in progress were targeted for early morning surveys, to attempt to locate emerging individuals. Study sites were located in two of the six swamp types where the species has been recorded in the Blue Mountains (Baird, 2012): a Blue Mountains Sedge Swamp (PMH01), and a Coxs River Swamp (PBB01) (for vegetation descriptions, see Benson & Keith, 1990; Keith & Benson, 1988). Meandering walking

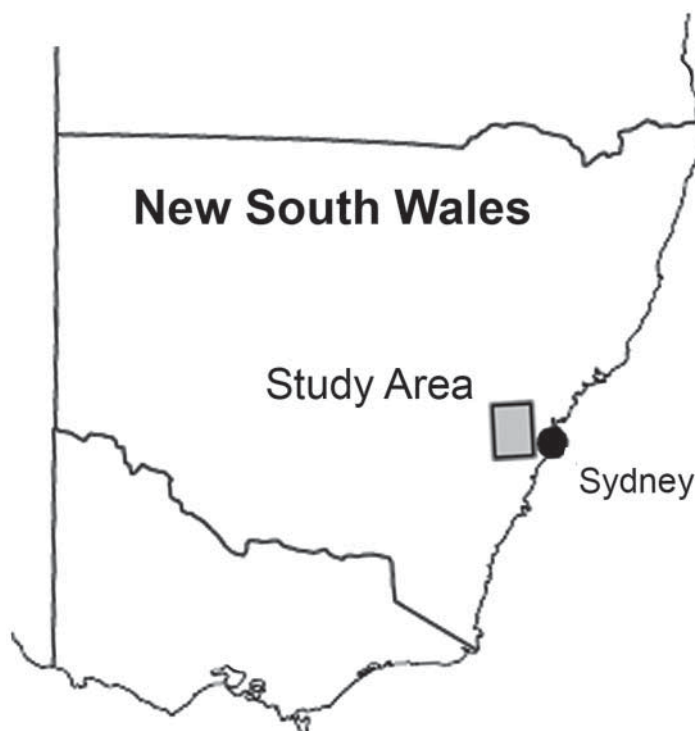


Figure 1. Location map of the Blue Mountains study area (shaded) (base map © 2005 Commonwealth of Australia).

Table 1. Observations of upright emergence in *Petalura gigantea* in the Blue Mountains, NSW, with timing of individual phases of emergence.

Site	Sex	Date	Time (solar time)							Duration of resting period (min)
			Commencement ecdysis	Commencement of resting posture	Completion of resting posture	Emergence from exuvia complete	Wings fully expanded	Abdomen fully expanded	Full coloration	
PMB01 ¹	♂	15 December 2003	06:49	07:06	07:35	07:39	08:07 ²	—	09:49 ⁷	29
PMH01	♀	12 November 2007	—	06:39 ³	06:46	06:53	07:24	08:15	09:36 ⁷	—
PMH01	♂	15 November 2007	05:42	05:53 (06:06)	06:21	06:27	06:51	—	—	28 ⁴ (15)
PBB01	♀	26 November 2008	06:57	07:22 (07:42)	08:19	08:28	09:20	—	— ⁶	57 ⁵ (37)

¹Previous record of upright emergence (Baird & Ireland, 2006).

²Wings expanded to the extent that they were longer than the abdomen (wings fully expanded time unavailable).

³Commencement of resting posture not observed, observation commenced at 06:39.

⁴Total duration of the upright resting phase includes two distinct upright resting postures, one immediately following the other; the first with the legs extended (commenced at 05:53), and the second with the legs held back close to the thorax (commenced 06:06, duration 15 min) in the typical resting position (Figure 2).

⁵Total duration of the upright resting phase includes two distinct upright resting postures, one immediately following the other; the first with the legs extended (commenced at 07:22), and the second with the legs held back close to the thorax (commenced 07:42, duration 37 min) in the typical resting position (Figure 2).

⁶When revisited at 10:32, the female had disappeared, presumably having taken flight.

⁷Determination of full coloration is highly subjective and times given should be taken as indicative only.

transects were undertaken in confirmed breeding habitat to locate emerging individuals. Surveys commenced near sunrise, when most *P. gigantea* apparently initiate ecdysis. When emerging individuals were located, the time of observations was recorded, and photographs were taken at regular intervals, to document the duration of individual stages of transformation.

Results

Three additional observations of upright emergence during the resting period in *P. gigantea* were recorded, two in PMH01 and one in PBB01. These observations are tabulated in Table 1. For comparison, the results of the previous observation of upright emergence in another Blue Mountains Sedge Swamp site in Medlow Bath, Blue Mountains (PMB01; Baird, 2012), reported by Baird and Ireland (2006) are included. Figure 2 illustrates the typical upright emergence posture during the resting phase observed in all four cases, with the legs held close to the thorax. Larvae typically perch vertically, or near so, while grasping a number of sedge stems or small shrub branches prior to commencing ecdysis. All four emergences commenced shortly after sunrise and the larvae in PMH01 (15 November 2007) and PBB01 were initially observed still ascending their emergence supports shortly before ecdysis commenced. In both cases, larvae were observed to rearrange their hold on perch vegetation to establish a secure emergence position. The weather was fine with no cloud for both emergences in PMH01; but misty, following light early morning rain in the case of the emergence in PBB01.

A notable observation, which was not mentioned by Baird and Ireland (2006), was the sequence of wing and abdomen expansion. Contrary to the reported sequence in Tillyard (1917), in each of the four emergence cases reported here, the wings commenced expansion before the abdomen and were effectively fully expanded before the abdomen commenced substantial elongation. After the wings were fully expanded, the abdomen elongated to be longer than the wings, which remain closed above the body. This sequence of wing and abdomen expansion is consistent with that



Figure 2. Upright emergence posture during the resting period in ♀ *Petalura gigantea* perched in *Leptospermum obovatum* in restioid-heath in a montane bog (PBB01) in the Blue Mountains, NSW, Australia, 26 November 2008 (photo by Ian Baird).

reported for *Tanypteryx pryeri* (Eda, 1959) and also with my partial observation of emergence in *T. hageni* (unpublished observations).

Discussion

The pattern of emergence for all three new observations of upright emergence was similar to the previous observation of Baird and Ireland (2006), with the exception of some features of the upright resting period in the individuals in PMH01 (15 November 2007) and PBB01. Both of these were characterised by an initial upright resting period with the legs extended away from the thorax, followed by a period with the legs held close to the thorax in the typical upright resting posture. In both cases during the initial resting phase, the individuals flexed their legs and slightly adjusted their posture on a number of occasions. It is possible that the particularly long duration of the upright resting phase in PBB01 was an effect of disturbance of the individual by the author immediately before or during ecdysis.

The effectively vertical position of perched exuviae reported here is consistent with perch position in the hundreds of exuviae observed during the larger landscape-scale study of which this study formed part (Baird, 2012). There were very few exceptions. In these cases, exuviae were located perched near horizontally or on sloping vegetation surfaces in bog vegetation, where emergence had occurred on low grazed herbland or sedgeland ("marsupial lawns") or on *Sphagnum* hummocks, without any adjacent ascending vegetation that may otherwise have provided more typical emergence supports (Baird & Burgin, in press).

In conjunction with the previous observation of upright emergence in *P. gigantea* (Baird & Ireland, 2006), the three additional observations of upright emergence in this study provide further evidence that this emergence style is the norm for the species, and that the original illustration of a hanging back style (Tillyard, 1917) was either an observation of an anomalous emergence or an instance in which Tillyard had incorrectly used *P. gigantea* to illustrate emergence using the hanging back style. Even if Tillyard had been aware of the upright emergence style in gomphids, the rather consistently vertical position of *Petalura* exuviae, compared to the often horizontal position of gomphid exuviae, could have influenced his choice of illustration of a hanging back emergence style in *P. gigantea*. Confirmation of emergence style in *T. hageni* would now help to resolve any outstanding questions in relation to emergence style in petalurids.

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